CHEMISTRY

at your service

AN EXHIBITION OF SOME ACHIEVEMENTS OF BRITISH CHEMICAL RESEARCH

at

THE TEA CENTRE

22 LOWER REGENT STREET

LONDON, S.W.1

5th–28th June, 1946

ICI

WELLCOME
LIBRARY
pam
QD 3
1946
I 34c

Foreword

WAR is a great stimulus to many kinds of scientific research. During the last war the British chemist gave convincing proofs that his resource and inventiveness are second to none.

This exhibition presents eight of his outstanding discoveries, either made or developed in this period. To have attempted to cover the whole wide field of British chemical research in one exhibition was impracticable. The method has therefore been chosen of focusing attention on those examples which are both notable in themselves as major scientific achievements and hold out promise of benefit to mankind.

It is of interest to note how in chemistry, as in other spheres, the developments of wartime have even greater uses in time of peace.

IMPERIAL CHEMICAL INDUSTRIES LTD.
NOBEL HOUSE
LONDON, S.W.I

22501433507

Chemical Research and Everyman

THE chemical industry is the true basis of the national structure. Its task is to supply all other industries including agriculture with raw materials. These number thousands, and many are fundamental. For example, without heavy acids and alkalies, the wheels of British industry would stop turning. Yet the chemist of today produces all this vast range of essential raw materials from five main sources—water, air, salt, limestone, and coal. All these, obviously, are to be obtained within Britain.

The British chemical industry relies more than any other on research. Consequently, chemical research affects, directly or indirectly, almost every phase of the daily lives of ordinary men and women. By promoting the growth and expansion of existing industries, and by creating new ones—such as those for the manufacture of plastics, drugs, and fertilizers—it provides employment for millions.

The British chemical industry is conscious of its responsibility. A high proportion of its best brains and a large part of its resources are devoted to research for new products or processes, or better ways of utilising established ones. This research is linked with the work of the scientists in the great British universities. There is a constant interchange of information. Chemical research is a national asset as this exhibition will, it is hoped, demonstrate.

The Chemist versus Disease

LESS than a hundred years ago, a woman was considered a beauty if she was not marked by smallpox. The fact that modern towns and cities, with their denser populations, are spared the ravages of this and other epidemic diseases is largely due to the disinfectants which the chemist has developed to kill germs before they can cause infection, and to the chemicals which he has evolved for ensuring the purity of drinking-water and the safe disposal of sewage and industrial waste.

In recent years, the most spectacular of the chemist's achievements have been in the field of chemotherapy. The war hastened the development of the sulphonamides and penicillin—drugs with potentialities that have still to be measured. It also directly inspired a third—the new anti-malarial, Paludrine.

THE SULPHA DRUGS

The substance from which all the sulpha drugs or sulphonamides derive is known chemically as *p*-amino benzene sulphonamide. Its remarkable germ-killing powers were first recognised in 1935. Setting to work on related compounds, British chemists produced sulphapyridine. This was the famous M. & B. 693, which placed a new weapon against pneumonia in the hands of the medical profession. In 1941 a further advance was made when I.C.I. research workers evolved sulphamezathine. This drug conquers bacterial infection without causing discomfort to the patient. Research also led to the development of sulphaguanidine—a drug which is widely used for dysentery, cholera, typhoid and typhus.

The enormous field for research offered by the sulpha drugs is still far from exploited, though their importance has been somewhat overshadowed in the popular imagination by what has been termed the 'wonder drug' of the age—

PENICILLIN

Penicillin is extracted from a common mould, such as may often be found on stale bread. The particular species of mould, known to biologists as *penicillium notatum*, had been identified long

before its medical possibilities were realised. These were only discovered when Professor Alexander Fleming, working at St. Mary's Hospital, London, observed that a mould had grown on one of his culture slides, and that in the neighbourhood of the mould all bacterial development had stopped. He published his results in 1929.

Nine years later, Professor H. W. Florey and Dr. E. Chain of Oxford decided to follow up Fleming's work. They prepared a purer specimen in powder form, and confirmed penicillin's anti-bacterial properties. Later, it was found that penicillin could be used to treat any infections that responded to the sulpha drugs, and that its action was infinitely more powerful.

During the war, penicillin played a vital part in the treatment of wound infections and gas gangrene. Further tests only served to underline its phenomenal powers. It was found to be effective against tonsillitis, puerpural fever, gonorrhoea, and staphylococcal meningitis—formerly an almost certain killer.

The knighthood, bestowed on Professors Fleming and Florey in 1944, was a national tribute to the genius of these men. The award of the Nobel Prize to Fleming, Florey, and Chain in 1945 placed the seal of world recognition upon their labours.

'PALUDRINE'

It is fitting that the chemist's greatest contribution to the treatment of malaria should have emanated from British laboratories. The threat of this dread disease hangs heavily over vast tracts of British Dominion and colonial territories. Malaria is, in fact, the greatest scourge of man. Its victims have been more numerous than those of all the wars in history added together. No fewer than three hundred million human beings suffer from it in the world today, and three million are computed to die from it every year.

Until recently, the only drug of real value against malaria was quinine, a natural substance extracted from the bark of the cinchona tree. Chemists have long sought to synthesise quinine, but their researches produced only two noteworthy substitutes—pamaquine and mepacrine. Mepacrine, considered by medical authorities to be the equal of quinine, is nevertheless not ideal. The need for a better anti-malarial became critical when the Japanese

overran the quinine-producing areas of the East Indies in 1942. The concentrated attack on the problem, then launched in the I.C.I. laboratories at Blackley, Manchester, was entrusted to two chemists, Drs. F. H. S. Curd and F. L. Rose, and a biologist, Dr. D. G. Davey. They broke entirely new ground in their researches, examining substances hitherto unexplored for anti-malarial activity. By 1945 they had achieved their goal in the drug now known as 'Paludrine.'

'Paludrine' is a comparatively simple compound, technically known as N_1-parachlorophenyl-N_5-isopropyl biguanide. It is more powerful, less toxic, and exerts a wider influence on malaria than does any other specific. To countless millions it means new hope, for in it, for the first time, are combined the properties of prevention and cure.

The Chemist and Your Food

THE greatest single issue facing humanity today is the production of adequate quantities of food. Nature alone cannot support the teeming populations of Europe and Asia, even in peace. She must be encouraged to produce more abundantly. There are many ways of doing this, almost all of them developed by the chemical industry.

Agriculture can now rely on the vast tonnages of synthetic fertilizers necessary to nourish crops. To make these fertilizers the chemical industry needs nitrogen, and this it obtains from the atmosphere.

The 'fixation' of atmospheric nitrogen for use in fertilizers was achieved by British chemical engineers during the First World War, after Sir William Crookes had warned the nation in 1898 that exhaustion of the Chilean nitrate deposits would lead to world starvation unless alternative sources of nitrogen were discovered and exploited. Today, most fertilizers are made from nitrogen drawn from the inexhaustible storehouse of the air.

'METHOXONE'

Important as fertilizers are, they are only half the battle for more and better food. Growing plants have to be protected against moulds, bacteria, and weeds. The eradication of weeds has always constituted a major problem for agriculture, since methods which killed weeds almost inevitably had harmful effects on crops also.

The first substantial contribution to a solution was the discovery in 1942 of a *selective* weed-killer. Known as 'Methoxone' (2-methyl-4-chlorophenoxy-acetic acid), this chemical has a devastating effect on weeds, yet is harmless to cereal crops or grasses.

'Methoxone' was discovered by I.C.I. chemists while they were experimenting with synthetic plant hormones in an effort to stimulate growth. In one experiment they discovered that, far from assisting growth, they were actually retarding it. Moreover, they found that all plants did not react in the same way—some were unaffected. Further tests led to the astonishing conclusion that only plants which began life with two leaves were affected. Those that first appeared with only one leaf were unharmed. As grasses and cereals belong to the one-leaf class, and most weeds to the other, here was a discovery of the first importance. In 1941, a series of synthetic plant hormones was produced, and from them 'Methoxone'—the one that showed most promise for agricultural purposes—was selected.

The largest field trials ever undertaken in Great Britain have since shown that 'Methoxone' eradicates the chief weeds that compete with cereal crops. Thus the problem of the wheat and the tares—which was old when Methuselah was young—has been brought a noteworthy step nearer solution.

The Chemist versus Insects

MAN'S success in his struggles against predatory and disease-bearing insects has been due in large measure to the armoury of synthetic poisons developed by the research chemist. Until recently, the difficulty has been to discover a substance that would be toxic to insects but not to human beings and the lower animals.

With this end in view, I.C.I. chemists began a special programme of research in 1942. Among the thousands of chemical compounds which they tested was benzene hexachloride (1-2-3-4-5-6-hexachlorocyclohexane), a substance which, as a matter of history, was first prepared by Michael Faraday in London about 1825.

The fact that benzene hexachloride possessed insecticidal properties was known before the war. What had never been determined was the constituent of it which exerted the destructive

action. The I.C.I. chemists applied themselves to the task of discovering and isolating this.

To understand the problem before them, it is necessary to explain what is known to modern chemists as "sterio-isomerism". This means that it is sometimes possible to obtain several substances which are chemically identical but have markedly different properties, depending on the arrangement of their atoms in space. Benzene hexachloride has this peculiarity.

'GAMMEXANE'

The crude product prepared by Faraday was later found to consist of four substances, which are known as its alpha, beta, gamma, and delta isomers. The noteworthy achievement of the I.C.I. chemists was their discovery that the insecticidal properties of benzene hexachloride reside almost exclusively in the gamma isomer. Isolated from the others, this isomer proved an extremely powerful killer of insects. In some respects it is the most deadly insecticide ever discovered, yet it is practically harmless to man and animals.

Today, 'Gammexane'—the name given to the gamma isomer of 1-2-3-4-5-6-hexachlorocyclohexane—is being used against all manner of insects, from bed-bugs, fleas, lice, and cockroaches to the mosquito (carrier of malaria, yellow fever, and dengue), the tsetse fly (sleeping sickness), and the African migratory locust.

Collaboration between the discoverers of 'Gammexane' and explosive experts has recently produced a novel method of utilising 'Gammexane' wherever insects infest storehouses or other confined spaces. This is the 'Gammexane' smoke pellet. When ignited, it produces a cloud which settles on walls and other surfaces, rendering them lethal to any insects that walk or alight upon them.

The Chemist and Plastics

THE meteoric rise of the plastics industry is mainly due to the research chemist, with his constant striving for new or improved materials. Today, plastics loom large in the popular imagination. There is indeed a danger that their potentialities may be exaggerated. The truth is that the established materials—glass, wood, steel, and concrete—will always be first choice for the purposes for which they are best fitted. Plastics are complementary. Their

real future lies in fields where the older materials are not satisfactory, or in developing entirely new applications for themselves.

Two new plastics which were brought to perfection by the exigencies of war are of particular interest today. These are 'Perspex' and polythene. Both are discoveries of British chemical research.

'PERSPEX'

Methyl methacrylate, the material from which 'Perspex' has been developed, was originally produced in 1930 as an interlaying medium for safety glass. For this purpose it proved a failure.

Methyl methacrylate has, however, the peculiar property of 'polymerising'—that is to say, its molecules tend to link up in long chains to form 'giant molecules'. This polymerised form is 'Perspex', which possesses outstanding transparency and lightness, and will neither splinter nor shatter like glass. Naturally, during the war it found its greatest use as the glazing material for the noses, shields, and turrets of fighting aircraft.

Important as these uses were, 'Perspex' has infinitely greater potentialities for domestic and industrial purposes. Today it is being used in corrugated sheets for roof-lighting, in prisms and lenses, for surgical and dental equipment, and for an apparently boundless variety of fancy goods for the home. While surpassing transparency is one of its greatest attractions, it is beautiful in a range of translucent colours.

Industrial artists are beginning to realise the unique charm of 'Perspex', and to use it as the medium for entirely new designs.

POLYTHENE

Polythene is one of the greatest discoveries in plastics of the past decade. Like 'Perspex', it is a polymer, but of a much simpler substance, ethylene, which is a constituent of coal-gas. Under normal conditions ethylene does not polymerise, but I.C.I. chemists discovered in 1933 that it could be made to do so under extremes of pressure and temperature.

The path of polythene's development was attended by many difficulties. Working with pressures and temperatures higher than any ever before used in industry proved hazardous. There were inexplicable explosions, and once the laboratory was almost wrecked; but the process was eventually brought under control.

The new plastic proved extraordinarily tough, flexible, and water-resistant. Most striking of all were its qualities as an electrical insulator.

The development of polythene came at the very moment when such a material was urgently needed for Radar. The first plant began production on 1st September, 1939—the day the Germans invaded Poland. Before it had produced a single pound, the order was given to double its scheduled output. The great technical superiority of British Radar over that of enemy nations was largely due to polythene. Without it, Radar could never have been brought so quickly to perfection.

Polythene also found wartime uses in telephones, radio and submarine cables, and as a waterproof packing for sensitive drugs, such as mepacrine.

In the ampler days of peace, its uses will be correspondingly greater. It is already being used for lamp-shades, handbags, acid-proof containers, funnels, and piping, and other new applications are being reported almost daily.

Clothing out of Monkey Nuts

For centuries man had to be content with natural fibres, animal or vegetable, for his clothing. Only in recent years, when the chemical industry began research on fibres, was any appreciable advance made in this field. The chemist has already succeeded in imitating the silkworm; now he has directed his attention to the wool-making operations of the sheep.

The sheep produces its wool by long and complex processes from the vegetable proteins on which it feeds. So far as wool production alone is concerned, this is slow and wasteful, since only a small percentage of the proteins consumed by the animal is converted into wool. The chemist has now succeeded in by-passing the animal and producing wool-like fibres direct from the monkey nut or ground nut that grows abundantly in many parts of the British Empire.

The protein, consisting of long chains of amino acids linked together, is extracted from the nut and made into a solution. This is forced through the fine holes of a spinnerette into a bath, where it thickens into fine thread. It has been named 'Ardil', because it has been developed at the I.C.I. laboratories at Ardeer, in Ayrshire.

'Ardil' is not a substitute for wool: its role is complementary. It can be used in conjunction with wool to produce lighter fabrics, or in union with cotton or rayon, when it gives warmth, fullness of handle, resilience, and crease-resistance to the mixture. Moreover, 'Ardil' is mothproof.

Conclusion

CHEMICAL research can never stand still. To the chemist, the discoveries of today are the spring-boards for greater developments tomorrow.

Penicillin, for example, was evolved from a mould. There are many kindred moulds, each representing virgin fields of research which await the investigator. 'Paludrine' was the product of an entirely new line of research. Polythene was born out of experiments at temperatures and pressures that were considered unworkable. It is impossible to guess at the discoveries of equal value which may be evolved by the same reasoning or technique as produced 'Paludrine' and polythene.

All the discoveries included in the exhibition were made by British chemists within a period of no more than fifteen years—1930 to 1945. No other nation can point to such a record of chemical achievement. Today British chemical research stands on the threshold of a new age, holding who knows what discoveries for the future benefit of mankind.

Printed in Great Britain at THE KYNOCH PRESS, *Birmingham*, 6